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Estimation of Land Surface Window (8-12 m) Emissivity from Multi-Spectral Thermal Infrared Remote Sensing -~A Case Study in a Part of Sahara Desert

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Land surface window (8-12 m: 800-1250 cm^{-1}) emissivity is an important parameter for estimating the longwave surface energy balance. The window emissivity can vary significantly, because the spectral emissivity ranges from 0.7 to 1.0 for bare soils and rocks in this range. Because the large part of the earth's total radiative emission is lost directly to space within the 8-12 m region, the knowledge of the surface emissivity is crucial in the study of earth-atmosphere system radiation budget. Several studies have been made to map the window emissivity using a global land classification map (surface type map) and corresponding emissivity calculated from spectral libraries. The advantage of this method is that it is possible to obtain global map. However, wide spatial variations of emissivity can be observed in rocks and soils, which are recognized as one only surface type such as barren or bare soil in the classification map. This study focuses on estimating the window emissivity from the emissivities of the five channels on the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). ASTER is a sensor onboard the Earth Observing System (EOS) Terra satellite launched in 1999, and has five channels in the thermal infrared region (8-12 m). Using this sensor, it is possible to estimate surface spectral emissivity for each channel at a spatial resolution of 90 m globally. A multiple regression was used to relate the five ASTER emissivities to the window emissivity. This regression was developed using two spectral libraries, ASTER Spectral Library and MODIS Emissivity Library. The window emissivities ranged from 0.80 to 0.99 for natural surfaces, such as, rocks, soils, vegetation, water, ice, and snow. The RMS error of the estimated window emissivity was less than 0.01 both in calibration and in validation. We applied this calibrated regression to emissivities computed using ASTER data acquired in 2001 and 2002 over a 240 km by 1200 km area in Sahara Desert, Africa. We compared the estimated window emissivities derived from regression with the ones expected from the classification map and found significant difference ranging from -0.08 to +0.07.

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